The Tool

Adapt-N is a web-based computational tool that uses a simulation model to integrate location-specific soil, crop and weather information to generate in-season N recommendations for corn (**Figure 1**). It incorporates high-resolution weather data and field-specific inputs on soil, crop, and management parameters to estimate in-season optimum N rates. It addresses most concerns with the static and generalized corn N recommendation methodologies (Stanford, 1973; Sawyer et al., 2006), which have limited ability to manage high variability in N response, especially in humid climates, and have inadequate nuance for site-specific crop management.

The Adapt-N tool is accessible (http://adapt-n.cals.cornell.edu) through any internet-connected device that supports a web browser. It is based on the Precision Nitrogen Management (PNM) model (Melkonian et al., 2005), which in turn is a re-coded and integrated combination of a corn N uptake, growth and yield model (Sinclair and Muchow, 1995), and the LEACHN soil water and N transformation model (Hutson, 2003). The crop model uses solar radiation, temperature and rainfall information to estimate the growth, development, and uptake of N and water by the crop, on a daily time step (**Figure 2**). Its version of LEACHN uses a "tipping bucket" approach and information on soil properties and weather to estimate how water from each rain event is stored in soil, lost to drainage, or evaporated over time. It also tracks the transformations and movements of N in the soil profile. Both models have been extensively tested and validated in field trials. An important feature is its dynamic access to gridded high-resolution (5 x 5 km) weather data (daily Tmax, Tmin, Precip), which allows for field-specific and timely adjustments of N recommendations. The weather database is derived from routines using National Oceanic & Atmospheric Administration's (NOAA) Rapid Update Cycle weather model (temperature) and operational Doppler radars (precipitation). For both, observed weather station data are used to correct NOAA estimates and generate spatially interpreted grids (DeGaetano and Wilks, 2009; Wilks, 2008). Soils information is derived from NRCS SSURGO datasets.

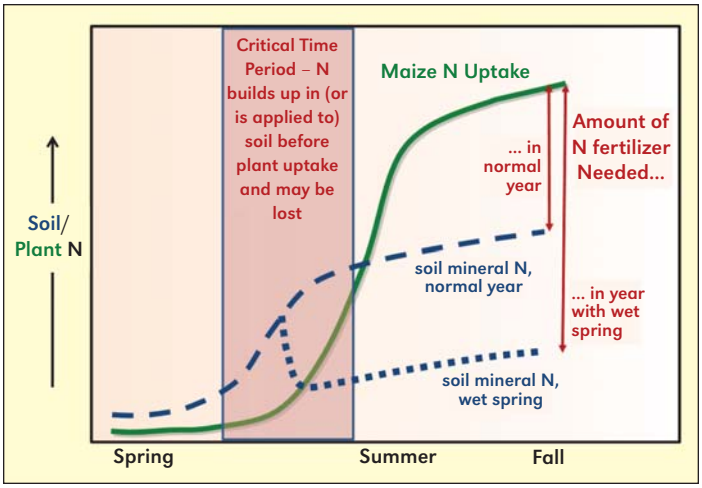

Figure 2. Adapt-N dynamically models the impact of weather on the soil N supply, soil N losses, and crop N demand.

Adapt-N uses dynamic simulations of soil and crop processes to feed into a mass balance equation that derives optimum N rates based on early season (deterministic, near-real time, currently within 1 day) and post-sidedress (stochastic, based on probability via 30-year climate data) simulation results. It provides uncertainty estimates for N rates, and also incorporates economic considerations (crop-fertilizer price ratio). It offers information on simulation results (N mineralized, N leached and denitrified, soil N levels) and allows for

Case Study: New York Farm Uses Adapt-N to Save Money and Reduce Environmental Impact

Donald and Sons Farm in Moravia, NY grows about 1,300 acres of corn and soybean annually. Until 2011, the farm used N application rates recommended by a commercial soil testing laboratory, which ranged between 195 to 260 lb N/A. The majority of their fertilizer N is applied as anhydrous ammonia at sidedress time, because early season applications run the risk of losses during wet springs. Only 22 lb/A of N is applied at planting as urea ammonium nitrate (UAN). Their large expenditures on N fertilizer were a strong incentive to seek new tools to optimize application rates and to collaborate with the Adapt-N beta-testing efforts. The web-based Adapt-N tool combines soil and crop models to predict the influence of weather on plant N demand, soil N supply and soil N losses.

After the dry 2011 spring, the Adapt-N recommendation for their trial field was only 80 lb/A. Their old recommendation was 220 lb/A, and they found no yield penalty with the substantially reduced N rate. For 2012, the farm decided to fully adopt Adapt-N and host numerous trials. They sidedressed 922 acres of corn using the tool's recommendations, employing their real-time kinetic (RTK)-GPS system to target variable rates on 90 management units distributed across 18 fields. Recommendations from Adapt-N varied from 65

to 190 lb/A, depending on local temperature, precipitation, soil texture and organic matter content (varying from 1% to 6%), as well as the date of sidedressing. In collaboration with the Cornell Adapt-N Team, on 15 fields, they left replicated comparison strips of the conventional "old" rate. Decreasing N applications by 87 lb/A reduced the simulated total N losses to the environment by 70 lb/A (by 15 December 2012), and reduced N leaching losses by 10 lb/A. Adapt-N resulted in profit gains in 83% of trials, and average savings were 42 $/A. For the farm, they saved 67,000 lb of unneeded N in 2012, with total savings of over $30,000.

By applying a science-based model of the soil and crop processes involved in the N cycle, their management of source, rate, timing and placement of N led to higher profit and reduced impact on the environment. The approach is consistent with the principles of 4R Nutrient Stewardship.

For more information, see http://adapt-n.cals.cornell.edu/